A Vehicle for Collaboration

The CAI Program Accomplishments:

- **Established an Industry / Government Team**
  (U.S. Air Force, U.S. Navy, Boeing, Northrop Grumman, Lockheed Martin & GEAE)
- **Provided the Forum for Competitors to Begin Sharing Data**
- **Defined Requirements, Planning and Goals**
- **Defined Cost Analysis Requirements**
- **Developed a Cost Analysis Tool - "CAICAT"**
- **Enabled Cost Analysis Tool Validation Verification**
- **Encouraged Cost Analysis Tool Acceptance & Utilization**

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CAI Background

Composites Affordability Initiative
Objective
Reduce the Acquisition Costs of Advanced Composite Structures by an Order of Magnitude
• National Collaboration Between Government / Industry
• Utilize Revolutionary Design / Manufacturing Concepts
• Develop Materials / Processes / Tools in National Industrial Base
• Provide Affordable Composite Structures
• Provide Increased Utilization/ System Performance
• Two Focuses
– Short - JSF-Type Fighter
– Long - Other Vehicles, High -Reductio-Potentia Technologies Which Cannot Be Matured in Current
BOEING
LOCKHEED MARTIN
NORTHROP GRUMMAN

- A cooperative effort between government and industry to reduce the cost of aerospace composite structures.
- This allows design engineers to take full advantage of their unique benefits.
- The CAI Program is a 50/50 cost share between Government & Industry.

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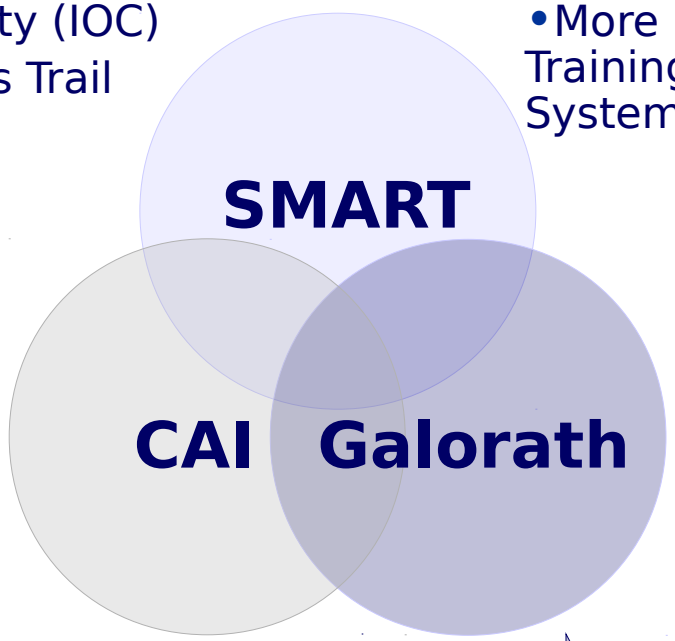
Synergistic Goals

SMART Goals

Reduced
- Total Ownership Costs (TOC)
- Time to Initial Operating Capability (IOC)
- Logistics Trail

Increased
- Supportability, Maintainability, and Military Worth
- More Effective, Cost Efficient Training At the Individual, Crew & System Level



CAI Goals

Reduce the acquisition costs of advanced composite structures by an order of magnitude

Galorath Goals

Enabling affordable plans that work, by answering the question: “Which way do we go?” early in the design stage of a program

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CAICAT Team Objectives

Primary Objective

- Develop a credible and rapid cost evaluation system for a military airframe, that can address state-of-practice, state-of-the-art and emerging design & manufacturing technologies.

The Customer

- The customer for CAICAT is a design integrated product team

The Modules

- The CAICAT modules should work both standalone and as part of an integrated process
- The data and practices embedded in the CAICAT suite, and the default results of the CAICAT modules, should reflect an industry average
- The module inputs should be easily modified to reflect differences in design and manufacturing practices
- Each module should have ability to be enhanced or replaced as member of the CAICAT suite

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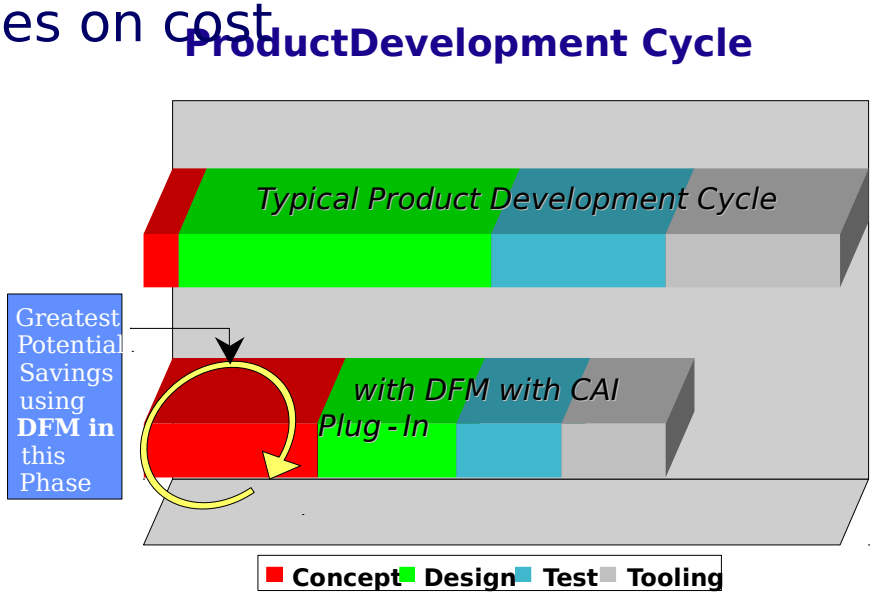
CAICAT Challenge

"Making Smart Decisions Early"

- Influence The Design Team and take full advantage of any potential savings **(as much as 80%)**
- The design community, early in the concept stage when important decisions are made, had no way to determine the impact of their choices on cost.
- "Proactive Costing"

  Not "Reactive Costing"
- Linking Parametric data and process data
- Linking CAD data and cost data



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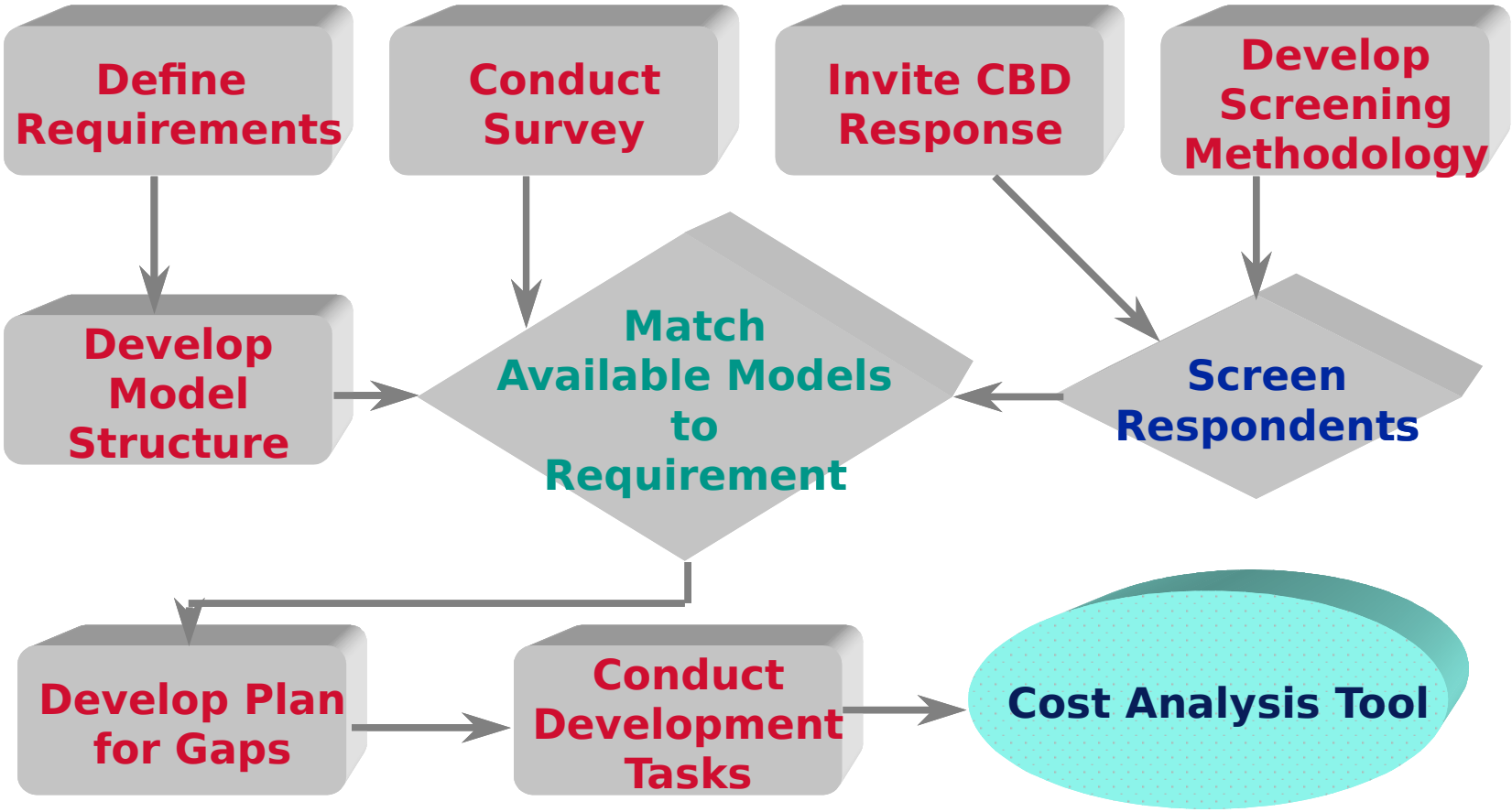
CAICAT Development Process



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SEER-DFM: CAICAT Solution

Solution

- The CAICAT Team Selected SEER-DFM to serve as its Plug-in.
- Galorath became a 50/50 cost share partner in CAICAT.

- CAI member companies are far along in the development of a software package, based on a commercial Design for Manufacturability tool (DFM) called SEER-DFM™, which gives designers a method to quickly evaluate the cost of alternate composite materials and manufacturing processes.

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Team Work

CAICAT Member Companies

T
E
A
M

- BOEING
- LOCKHEED MARTIN
- GE Aircraft Engines
- GALORATH
- Air Force Research Labs
- NORTHROP GRUMMAN
- Navy Science & Technology

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Why SEER-DFM?

- **Provides Design Team with the ability to make smart decisions from the "Back of the Napkin" to the CAD Program Phases, which reduces downstream manufacturing costs**
- **Provides the Design Team with Real Time Cost Feedback**

- Shortens Development Cycle
- Provides a Cost Compass
- Documents Trade Study Process
- Increases Trades Quantity
- Multiple Site Collaboration
- Customization Via Plug-in
- COTS Solution
- Commercialization
- Expandable
- Auto Data Import/Export
- Linking to PDM's
- 24/7 Support

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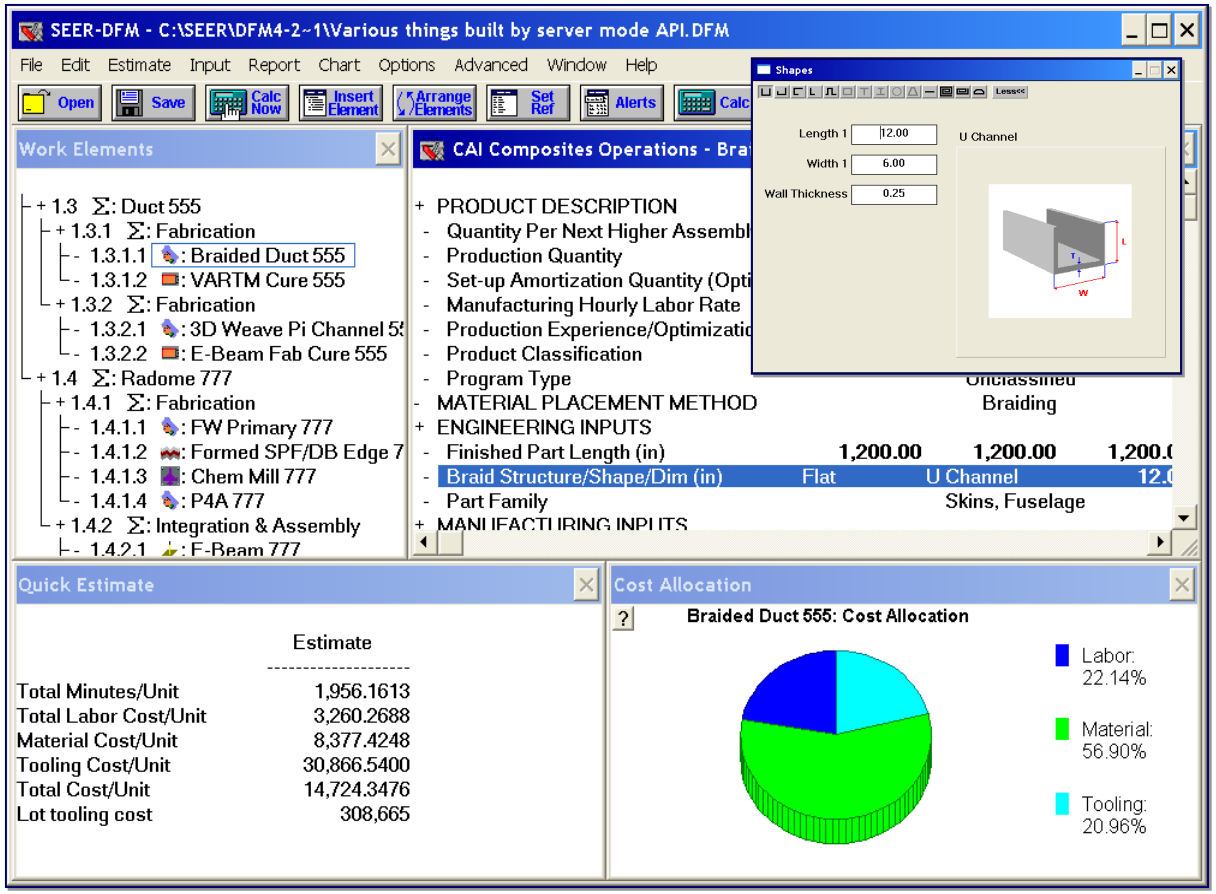
SEER-DFM Customization

- Based on Aerospace Industry Standards


SEER-DFM - C:\SEER\DFM4-2~1\Various things built by server mode API.DFM
File Edit Estimate Input Report Chart Options Advanced Window Help
Open Save Calc Now Insert Element Arrange Elements Set Ref Alerts Calc
Work Elements
+ 1.3 Σ: Duct 555
+ 1.3.1 Σ: Fabrication
- 1.3.1.1 : Braided Duct 555
- 1.3.1.2 : VARTM Cure 555
+ 1.3.2 Σ: Fabrication
- 1.3.2.1 : 3D Weave Pi Channel 5
- 1.3.2.2 : E-Beam Fab Cure 555
+ 1.4 Σ: Radome 777
+ 1.4.1 Σ: Fabrication
- 1.4.1.1 : FW Primary 777
- 1.4.1.2 : Formed SPF/DB Edge 7
- 1.4.1.3 : Chem Mill 777
- 1.4.1.4 : P4A 777
+ 1.4.2 Σ: Integration & Assembly
- 1.4.2.1 : E-Beam 777
CAI Composites Operations - Bra
+ PRODUCT DESCRIPTION
- Quantity Per Next Higher Assembl
- Production Quantity
- Set-up Amortization Quantity (Opti
- Manufacturing Hourly Labor Rate
- Production Experience/Optimizatic
- Product Classification
- Program Type
- MATERIAL PLACEMENT METHOD Braiding
+ ENGINEERING INPUTS
- Finished Part Length (in) 1,200.00 1,200.00 1,200.0
- Braid Structure/Shape/Dim (in) Flat U Channel 12.0
- Part Family Skins, Fuselage
+ MANUFACTURING INPUTS
Shapes
Length 1 12.00
Width 1 6.00
Wall Thickness 0.25
U Channel
Quick Estimate
Estimate
Total Minutes/Unit 1,956.1613
Total Labor Cost/Unit 3,260.2688
Material Cost/Unit 8,377.4248
Tooling Cost/Unit 30,866.5400
Total Cost/Unit 14,724.3476
Lot tooling cost 308,665
Cost Allocation
Braided Duct 555: Cost Allocation
Labor: 22.14%
Material: 56.90%
Tooling: 20.96%

- Recognized by Industry and Customers, both Air Force and Navy, as a tool set that can influence Designers & Design Teams to make affordable designs in “real-time”

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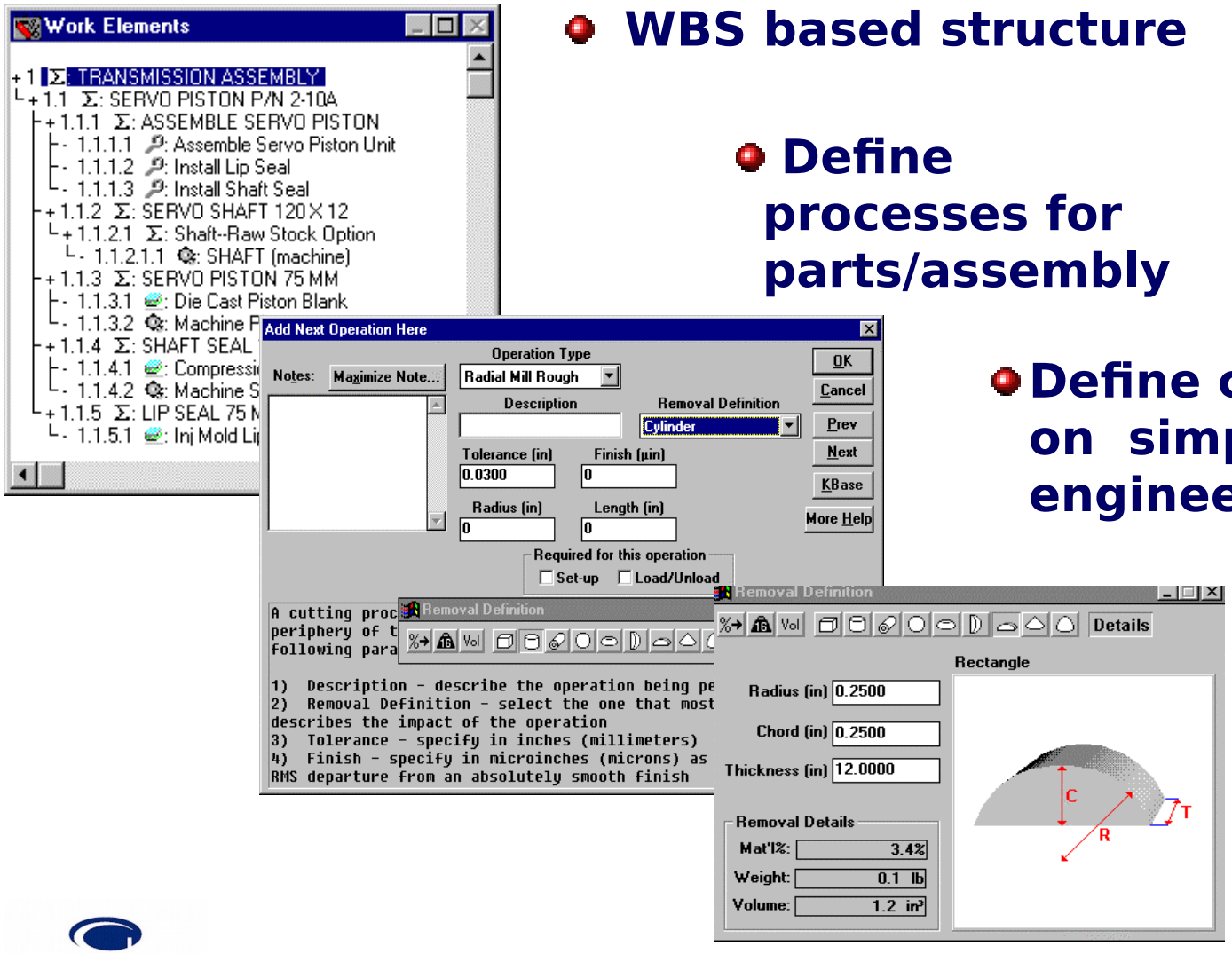
SEER-DFM Parameter View



- **WBS based structure**
  - **Define processes for parts/assembly**
- **Define cost based on simple engineering data**

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Extensive Processes

Composites
3D Weaving
Braiding
Filament Winding
Hand Layup
P4A
Tow Placement

Fitup

Drill Operations

Fastening

Paste Bond

E-Beam Assm

3D-Reinforcement

Composites
Hand Layup
Filament Winding
Tow Placement
P4A
Braiding
3D Weave

Assembly
Fasten
Fit-up
Drill
E-Beam Assembly
Paste Bond
3D Reinforcement
Automated Assembly

Cure
Autoclave
RTM
VARTM
E-Beam Fabrication

Fabrication
SPF/DB
Sheet Metal
Trim

Tooling

Cure Methods
Autoclave
E-Beam Fabrication
RTM
VARTM

Sheet Metal

SPF/DB

Trim

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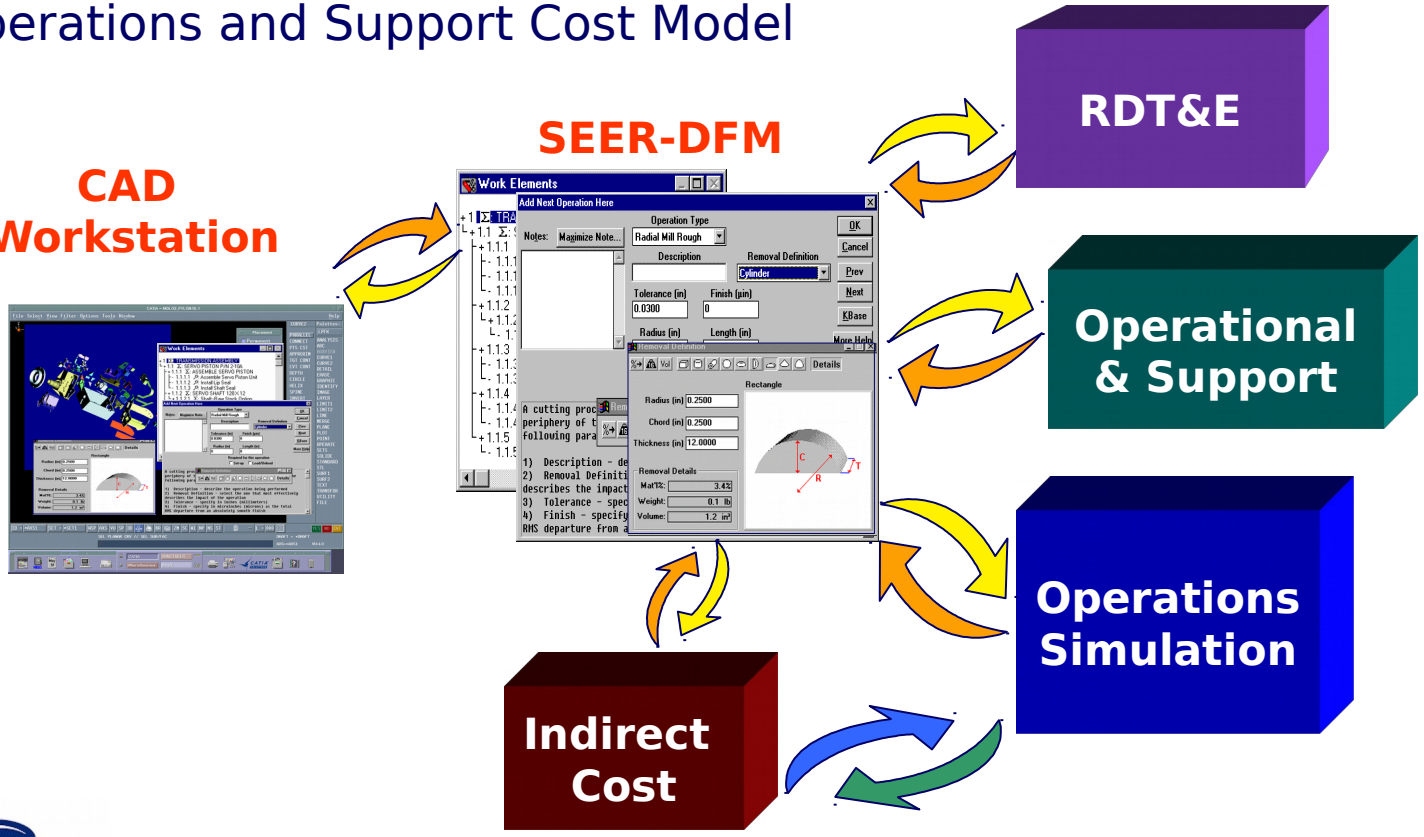
CAICAT Subsystems

- SEER-DFM with CAI Plug-in
- RDT&E (Research, Design, Tooling and Engineering) Cost Model
- Operations Simulation Model
- Indirect (Acquisition) Cost Model
- Operations and Support Cost Model



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Where Are We Now?

CAICAT Status:

- The team is currently in phase 3 of its multi-phase program.
- In phase 2, the CAI program developed the contributing systems, or cost models, and a prototype integration of those models. The CAI program also developed a trial integration with CATIA and UNIGRAPHICS.
- The present task is intended for completion of the integration of the above models in a CAD (CATIA and UNIGRAPHICS) environment so that the entire system can be maintained and commercialized in the future. The industry participants and the government each have a variety of legacy tools, processes and data that must be integrated by each member to be directly useful within each member's organization.

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Conclusion

Fostering Collaboration: A Success Story

Although it's difficult to attach an ROI to collaboration, the success of the CAI Team can easily be measured by its accomplishments, such as:

- Creating a forum for contractors to share data between each other; the first forum of its kind.
- Contractors sharing their data with the government agencies and model builders; another first of its kind.
- A suite of commercially available software tools for all of the U.S. industrial base to use
- Parametric based tools and process based tools linked together and sharing Data

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To Learn More

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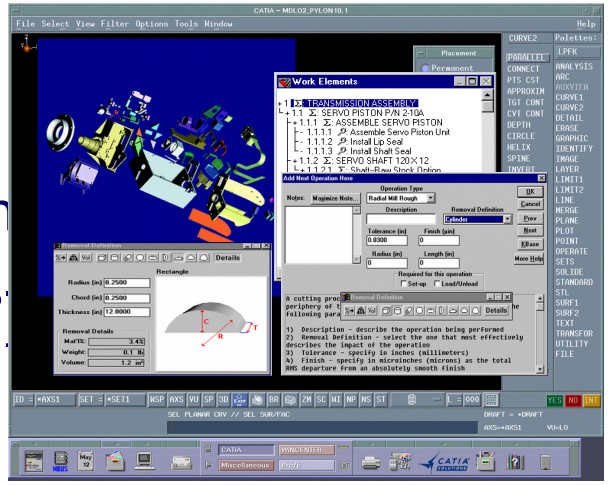
Current Status, Continued

- Galorath was selected to do the Integration for Phase 3
- CAICAT Integration was not funded for FY 02
- Individual member companies are working with Galorath on custom solutions
- Galorath is working with CAD extraction companies to formulate a phased plan to accomplish costing “on the fly”
- Linking CAD and SEER-DFM
- Galorath and contractors working on both Comanche and Apache
- Continuing to decrease cost by usin
  a Parametric approach and process-based models, as well as linking Data

SEER-DFM w CAD Plug-in can be served to any Design Work Station



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Success in Design Affordability

The building of specific design cost tool modules for the U.S Aerospace industry has become the foundation from which to begin the process of setting cost analysis standards and metrics.

Through its effort, the CAI has:

- **Produced a common approach** to cost analysis which is a fundamental way to lower costs, inject change and project future cost with confidence.
- **Proven the use of multiple techniques**, such as parametric and process based estimating in conjunction with risk analysis, is not only possible but is encouraged.
- **Set Goals** to combine the use of commercially available solid or computer aided design models (CAD), parametric, process based and risk analysis cost modeling all integrated to work as one modeling space.

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The Composites Affordability Initiative (CAI)

The Benefits of Getting the U.S. Government and Airframe Producers to Cooperate

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ARMY /SMART Conference
Salt Lake City, UT
April 2002

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